Proposed Techniques for the Assessment of Recreational Invertebrate Harvest in British Columbia

J. R. Carmichael and N. Bourne

Department of Fisheries and Oceans
Fisheries Research Branch
Pacific Biological Station
Nanaimo, British Columbia V9R 5K6

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PROPOSED TECHNIQUES FOR THE ASSESSMENT OF RECREATIONAL INVERTEBRATE HARVEST IN BRITISH COLUMBIA

by

J. R. Carmichael[1] and N. Bourne

Department of Fisheries and Oceans
Fisheries Research Branch
Pacific Biological Station
Nanaimo, British Columbia V9R 5K6

[1]Present address:
441 Arnold Avenue
Victoria, B.C.
V8S 309

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ABSTRACT

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Invertebrate resources in British Columbia support a valuable recreational fishery that has increased significantly in recent years. Although there are programs to assess the recreational finfish fishery in British Columbia none exist for the recreational invertebrate fishery. This report describes available information on recreational invertebrate fisheries in British Columbia, discusses the appropriateness of using existing finfish programs to obtain further information on them, and examines programs in the United States to assess recreational invertebrate fisheries. Methods are proposed and discussed that would permit collection of information on the recreational invertebrate fishery in British Columbia that could lead to a more accurate assesssment of the impact of this fishery on the resource.

Key words: recreational invertebrate fishery, British Columbia, assessment methods

RESUME

Carmichael, J. R. and N. Bourne. 1986. Proposed techniques for the assessment of recreational invertebrate harvest in British Columbia. Can. MS Rep. Fish. Aquat. Sci. 1869: 30 p.

Les ressources en invertébrés de la Colombie-Britannique font l'objet d'une pêche sportive importante qui a connu beaucoup d'ampleur au cours des dernières années. Bien qu'il existe des programmes pour évaluer la pêche sportive des poissons en Colombie-Britannique, il n'en existe aucun pour la pêche sportive des invertébrés. Le présent rapport donne les renseignements disponibles sur la pêche sportive des invertébrés qui se pratique en Colombie-Britannique, discute de l'opportunité d'utiliser les programmes existants sur les poissons pour recueillir de plus amples informations à ce sujet et examine les programmes en place aux États-Unis pour évaluer la pêche sportive des invertébrés. On propose et on examine des méthodes qui permettraient de recueillir de l'information sur la pêche sportive des invertébrés en Colombie-Britannique et qui pourraient mener à une évaluation plus précise des répercussions de cette pêche sur la ressource.

Mots-clés: pêche sportive d'invertébrés, Coloumbie-Britannique, méthodes d'évaluation

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INTRODUCTION

Marine invertebrate resources in British Columbia support small but important commercial fisheries and are also widely used in recreational fisheries. In commercial fisheries, species harvested and catch are reported annually and there have been numerous studies to provide information to formulate management policies for these fisheries. The recreational fishery for invertebrates has not been assessed and little information is available for it. The belief until now has been that this fishery is minor and catches are insignificant. Some information was provided by Fishery Officers while on regular patrols to assess the sport salmon fishery. However, in recent years even this source of information has been greatly curtailed because of manpower and funding restrictions.

There is general agreement within the Department of Fisheries and Oceans (DFO) that recently there has been a significant increase in the recreational harvest of some invertebrates for several reasons including; better road access to many areas, more people with more spare time to harvest invertebrates, people developing a fondness for seafood, a greater influx of tourists, and the growing popularity of such sports as SCUBA diving. A 1980 study in statistical area 29 estimated that 31,000 individual dungeness crabs, Cancer magister, (20 tonnes) were caught in the sports fishery which is approximately 17% of the commercial catch in the same area (Ketchen et al. 1983).

Instances of heavy shellfish exploitation in British Columbia are probably not isolated and indicate the need for close study and monitoring of this fishery. The recreational fishery will undoubtedly continue to expand as human populations increase. Conflicts already exist between recreational and commercial fisheries and they will increase as the recreational fishery expands. Meaningful management policies can only be formulated if the extent and impact of the recreational invertebrate fishery is known.

Examples of the significance of recreational invertebrate fisheries are seen in the United States. In the State of Washington in 1977, 13 million razor clams were harvested by recreational harvesters compared to only 3 million in the commercial fishery. In Puget Sound between 1972 and 1978 the recreational harvest of hard-shell clams, mainly butter, Saxidoumus giganteus, littleneck, Protothaca staminea, and manila, Tapes philippinarum, was over 1000 tonnes per year (Schink et al. 1983). The relatively small prawn fishery in the state has a season that favours recreational harvesters. Both Oregon and California have had to introduce fishery assessment and management schemes to protect invertebrate stocks.

The purpose of this report is to identify methods to assess recreational invertebrate fisheries in British Columbia. Most emphasis is on molluscs and crustaceans since they are the major target species, but other invertebrate fisheries are reviewed. Species most commonly harvested in this fishery are listed in Table 1. The validity of existing sport fishery assessment programs for gathering the needed information on recreational invertebrate fisheries is discussed, and sampling methods are proposed.

AVAILABLE INFORMATION AND EXISTING PROGRAMS

Fishery Officer Questionnaire

An initial goal of this study was to determine what information already exists on recreational invertebrate fisheries in British Columbia. After discussions with some Fishery Officers a questionnaire was composed and distributed to Fishery Officers in all statistical areas along the coast (Appendix 1).

Results of the Questionnaire

Two facts emerged from the questionnaire. First, even in areas of high population and high recreational shellfish use, DFO has never monitored the recreational shellfish harvest in a formal manner. Second, while having no formal survey data, Fishery Officers have good knowledge of major recreational invertebrate fisheries in their areas.

Target Species of Recreational Harvesters

In the South Coast District (south of Cape Caution), crabs and clams are the two primary target groups of invertebrates taken in the recreational fishery. The species most in demand depends to some extent on beach access, type of shoreline and general type of fishing in the area. Oysters and prawns are the next most popular species. Oysters are in demand everywhere in the Strait of Georgia and in Barkley Sound. Recreational harvesters are learning to catch prawns and shrimp and this is a growing recreational fishery. Depths at which prawns occur, regulations on number of sport traps, and restrictions on power for pulling traps have been limiting factors in development of this fishery. Abalone and rock scallops are taken in small numbers by divers where available. Abalone are harvested mostly in the Victoria area and on the west coast of Vancouver Island. Mussels, squid, octopus, sea cucumbers, and sea urchins are taken by a small number of recreational harvesters in scattered locations along the South Coast.

In the North Coast District (north of Cape Caution) crab is the main recreational invertebrate target species and harvest is mostly by trap fishing although rings are popular in some areas. There are some areas where it is popular to harvest crabs (and other species) by walking along the waters edge at low tide and pick them up, (low tiding). Abalone is the second target species. These are mostly taken by diving, although there are several popular locations for low-tide harvest in the Prince Rupert area. Clams followed by prawns and shrimp are other species harvested by recreational fishermen in the North Coast District.

Fishing Patterns of Recreational Harvesters

Harvesting pressure in the North Coast District is mostly near population centres. In the central part of this district harvesting pressure is mostly transient. While waiting for fishing openings, herring and salmon

fleets are often the largest recreational users in an area. The second influx of people occurs during the summer cruising season when large numbers of boaters and charter boats are present.

In the South Coast District the number of local and tourist recreational harvesters varies with season. In winter most of the harvest is by local residents. In summer however, due to greater accessibility than in the northern area, the catch can be up to 90% by tourists in some areas. Areas such as Powell River, Parksville/Qualicum, and Alberni/Tofino, have large numbers of tourists moving into the area. Other areas like Nanaimo have only about a 40% tourist fishing population. Victoria and Vancouver have such large numbers of local fishermen that even though large numbers of tourists may be in the area the percentage may only represent 5-10% of the total number of recreational harvesters.

There are differences in harvest patterns between locals and tourists. Locals usually go after one target species but tourists tend to harvest a variety of species. Local harvesters may go out several times throughout the year but tourists may go out every tide of every day during their holiday to maximize their catch.

Charter Operations

Another series of questions dealt with the number of charter boats and lodges operating in each area and the types of invertebrate harvest provided for their patrons.

There is a large range in number (0-250), size and type of charter boats operating in different areas. Many salmon charter boats are only 5-6 m and operate on an irregular or part time basis. Isolated lodges and large charter boats may sometimes be secondary shellfish harvesters and Fishery Officers stated there were a few of these types of operations in most areas; the Queen Charlotte Islands may have one or two such operators in the southeast section. The largest concentration of such operations in the North Coast District is in Rivers Inlet where there are three major boats and nine lodges. These are primarily salmon operations with minor harvest of shellfish for patrons.

In the South Coast District, the Sunshine Coast has a few large charter boats, with some remote lodges in areas 12 and 13. Areas such as Powell River, Barkley Sound and the Gulf Islands have a large number of dive charters each year.

Comments from Questionnaires

In many areas Fishery Officers remarked that "this area is closed to bivalve harvest because of paralytic shellfish poisioning (PSP)" but often followed this with the statement that clam harvesting is one of the major recreational fishing pursuits in the area. People are either unaware of the closure and its consequences, or are taking a chance on harvesting non-toxic clams.

The Fishery Officer questionnaire provided general information on recreational fisheries along the coast that might be useful in more intensive

studies. However, no quantitative information was obtained from this questionnaire, except for the crab study in area 29. It is necessary to obtain quantitative data if an accurate assessment is to be made of the impact of the recreational fishery on invertebrate stocks.

Tidal Diary Program

The Tidal Sportfishing Diary Program was initiated in 1979 by DFO to obtain estimates of the sport salmon catch. During the first two years of the program, emphasis was placed on developing practical survey methods. Major problems were identifying the sportfishing population and the need for more efficient data gathering techniques (Bijsterveld 1983). Initially this program dealt with problems that will be encountered in a sampling program for recreational invertebrate fisheries. In 1978 there was no tidal license, so there was no population base to survey sport fishermen. Methods used in this program at that time and problems associated with them could be useful in developing surveys for recreational shellfish harvesting.

This program was devised to provide statistically reliable information and covers a sample of tidal water license holders, but is on a volunteer basis. If volunteers are more interested in the resource or better fishermen they can bias results. A problem using this program to assess recreational shellfish fisheries is that the tidal license is designed to sample people harvesting finfish. People who harvest shellfish recreationally do not require a license and many do not purchase tidal licenses. A significant portion of shellfish harvesters and their catch could be missed by using this program.

Resident Boating in Georgia Strait. Update 1979

Another program that used survey and questionnaire techniques was a survey of resident boaters in the Strait of Georgia carried out by the Small Craft Harbours Branch of DFO. The study was directed at updating baseline data from an earlier study on number, value, and usage patterns of recreational boats in the Strait of Georgia (Harrison 1979).

This report could be useful in assessing recreational harvest of invertebrates. It gives details of the survey method used, response rates, and examples of questionnaires. The survey provides some useful insights into patterns of use by boaters in the area, and possible number of recreational boaters in an area. It includes boat rental patterns as well. The last question asked how many crabs were caught during the year. This information is broken down into average number of crabs caught per boat by various areas and would be useful in surveying trap fisheries in any area.

Georgia Strait Creel Census Program

This program only encompasses the Strait of Georgia and is designed to provide a controlled comprehensive statistical sampling procedure

that could be employed in estimating catch and effort statistics in the salmon sport fishery (DPA 1982). In developing this sampling system DFO was looking for a method that would produce reliable information on the sport catch of salmon and other finfish in Georgia Strait for in-season management decisions. The DPA (1982) report details steps taken to arrive at the survey design and problems associated with each step. Information on costs involved with overflights and ramp samplers, as well as logistical problems faced in the program are available.

This program may be useful in recreational invertebrate surveys. Methods employed to cover wide areas and gather detailed catch and effort data are needed for intertidal fisheries. Methods used to train both interviewers and flight observers would be useful. Present data may indicate areas of concentration of crab pot fishing and times of year these activities are popular.

Some information in the program may be useful in monitoring recreational invertebrate fisheries but the data is inadequate to provide an accurate assessment of this fishery. The Creel Census Program was designed to provide information on finfish, information on invertebrates was ancilliary. The survey deals only with boaters, while access to many invertebrate fisheries in the South Coast District does not require a boat. Overflights in this survey only counted boats that were trolling or mooching. This would eliminate boats that are anchored for diving or beached for clam digging. This survey allows no transfer of effort directed at invertebrates to the interview harvest data, so no area wide estimates for invertebrates are available.

Recreational SCUBA Fishery

In August 1983 a project was undertaken to assess characteristics of the SCUBA fishery to determine geographic distribution of diving effort and the relative importance of fish and shellfish collecting activities. The study area was confined to the area from Victoria to north of Campbell River (Fisheries Statistical areas 13-19 and 29-29) (McElderry and Richards 1984).

The study was done in two parts: a survey of airfills at all dive shops within the study area to determine diver activity, and a voluntary self administered questionnaire distributed to selected dive shops. This questionnaire was used to estimate overall activity in terms of location and principal activity (McElderry and Richards 1984). The dive profile consisted of five activities, three of which were collecting activities: spearfishing, collection of edibles, and collection of nonedibles. A second portion of the questionnaire dealt with species collection preference in more detail and included all the important fish and invertebrate species. This study established a base population of divers in the area for any further study, a diver and dive profile to show how diving effort is spent, where diving activity takes place and mobility of divers, what is preferred for harvest, and patterns in amounts harvested. Of all of the studies on recreational fishing in British Columbia, this one provides the most information on recreational invertebrate harvesting.

This study (McElderry and Richards 1984), showed that during the survey period (Oct.-Nov. 1983) 50% of the total diver population harvested something edible on their most recent dive and 44% harvested shellfish. However, only 10% of the survey population indicated their most recent dive was principally for collection of edibles. Of the surveyed population, 74% indicated that they collected at least one invertebrate group while diving.

Figure 1 shows the distribution of dives throughout the study area. The sample size was too small to reliably describe geographic distribution of collection activities. However, distribution of dives and collection information provides an indication of the types of pressure divers can place on invertebrate resources. This and other parts of the study on diving distribution would be useful in determing areas where sampling effort may be needed, and when coupled with species preference information should give an idea of what level of effort if any, is needed to sample these areas.

Various problems with the data and data collection are identified in the report. It is difficult to find an independent check on accuracy of air fill collections by dive shops in this type of study and the size of the potential group (number of divers) to be sampled is unknown (McElderry and Richard 1984).

METHODS FOR ASSESSING RECREATIONAL INVERTEBRATE FISHERIES

Intertidal Fisheries

It is evident from preceding sections that information from Fishery Officers and existing sport fishery programs does not provide adequate data on the recreational invertebrate fishery. To adequately assess the impact of the recreational fishery on invertebrate stocks it will be necessary to design sampling programs specifically for this fishery. The remainder of this report outlines methods to assess the recreational invertebrate fishery. Major consideration is given to recreational clam digging, but other species including crabs, abalone, rock scallops, mussels, oysters, and octopus are also considered (Table 1).

A first task in determining the extent of recreational harvest is to identify the distribution of effort, particularly on beaches that are heavily used by recreational harvesters and gather information on species taken, volume and pattern use, and access to each.

The simplest type of beach to sample has a single access point, well defined limits and moderate to high use. However most clam beaches in B.C. are far from ideal for sampling purposes. They may have well defined limits, but few have limited access or else are only accessible by boat. In these cases the sampler must undertake interviews and sampling by walking along the beach. Some beaches are large, and will require subsampling by establishing well defined sampling areas.

The following information is required in sampling intertidal beaches.

1. Temporal Use (Beach use over time)
2. Physical Beach Use (Where harvest is occuring)
3. Species use
4. User efficiency or CPUE
5. User profile

Temporal Beach Use

Beach use over time can be collected by counting number of people on the beach at specific time intervals throughout a tidal cycle. Williams (1979) observed that most crabbers on Puget Sound beaches started about two hours before low tide and began to leave about .5 hours before low tide. Average time spent crabbing was 1.5 hours.

It is also possible to construct counts of users over time for the beach from interview data which can be used to check half hourly counts. Constructed counts will decline in accuracy as the percentage of fishermen interviewed drops. Monthly use curves can be generated from daily use curves (Williams 1975; Miller and Gotshall 1965). All intertidal sampling should extend for a full tidal series.

Counting at half hour intervals 2 to 3 hours on either side of low water should be sufficient to assess recreational harvest of species being considered. This generates a curve of Users vs Time (Fig. 2).

Physical Beach Use

During beach counts, samplers can determine locations of harvesters so effort can be plotted. This is important on the first few samplings, to establish limits for the area actually used by harvesters. This information can be used later by samplers doing single beach counts to ensure speed and uniformity in samples.

The fishing pattern of recreational harvesters is largely dependent on distribution of species being harvested. Crabbers will use the tide to concentrate crabs at the low water mark. Therefore one can expect crabbers to be on the beach with the falling tide and be concentrated in shallow water up to thigh depth. They will be moving constantly. Because abalone will be at the extreme edge of low tides, harvesters will be out only at extreme low tides. Again this is a walking fishery. Once the tide turns most abalone and crab pickers will leave. Clam diggers tend to arrive on the beach, find an area with good population and remain there until they have their limit and hence are easier to sample.

Most recreational users arrive at the beach prepared to begin harvesting as soon as the tide reaches a suitable level. Time spent fishing can be defined as the time between arrival on the beach and leaving,

provided they have not gone walking after getting their limit. This has been found to be the best estimate of user time in most surveys unless there is a long time spent in preparation (dive fisheries), (Miller and Gotshall 1965).

Species Utilization and User Efficiency

Information on species use, user effort, and user profile can be gathered by doing beach interviews, or at limited access points as people leave the beach. At this time the catch is sorted into species and weighed. If time permits and the harvester is accommodating, the catch or sample of it is measured to generate length fequency curves. There are three methods available to measure samples. Caliper measurements of the catch are accurate but slow. If the target species is crab or abalone this method is suitable because catch limits are low and allow all of it to be measured. In clam fisheries the board and bucket method is an alternative that can be used. A sampling board is made by cutting a series of holes, each larger by increments designated for that species. After the catch is sorted by species, individuals are then tried in progressively larger holes until they just fit and recorded as in that L/F group. With the board placed over a bucket this method is quick and can be done by one person. However different boards are required for some clam species, and the designated length groups have to be well established to take into account variance in growth with age.

A third method is to set up a photographic unit that will allow one to lay the catch out in a monolayer and photograph it. Clams can be measured with calipers from the photo. This method is more costly and requires good on-site labelling procedures, but is fast.

User Profile

User profile information can be collected by distributing a user questionnaire after measuring and weighing the catch. This short questionnaire gives information that together with catch and temporal use data allows future sampling to be adopted to that beach as well as showing overall catch patterns. If the beach is extrememly busy user profiles and catch measurements must be done on a sample basis. This can be done by standing at the access point and sampling every Xth person coming off the beach, or randomly selecting people while they are harvesting. An alternative method is to print the user profile on a post card and distribute them to people to fill out as they leave the beach or distribute them to people on the beach. The post card system can be modified so the person sampled fills it out on the spot and returns it to the sampler. This is cheaper and tends to reduce the non-response group. A well thought out request giving reasons for gathering the information helps. Potential questions for clam harvesters appear in Appendix 2.

On beaches with a single shore access it is possible to gather information on a voluntary self-creel census. The Washington State, Department of Fisheries tried this for jetty and breakwater sites used by anglers in 1974 (Fraidenburg 1976). Fishermen's cooperation was solicted by 1.2 x 2.4 meter signs at the access point. Photo guides for species

identification and questionnaires were left in a box at the sign. Harvesters filled in the questionnaire and deposited them in another box. The validity of the data and proportion of fishermen completing forms was determined through random interviews, and surreptitious observation of jetties. Total effort estimate is generated by dividing the proportion of fishermen completing the questionnaire into the total number of anglers reported on the questionnaire. Responses tend to be biased toward successful fishermen so catch estimates cannot be made from the questionaires alone but should be coupled with random interviews.

The previous system allows gathering of detailed information for each beach sampled. The problem with the system is that to cover a large area takes many samplers, and all must be on the beach at the same time on the same limited number of days per month.

One method of extrapolating information from an intensively sampled beach to other similar beaches in the area is to observe other beaches at a given time. At this point, the people on the beach are counted, and using ingress/egress information and user curves, projections can be made for other beaches. Some work must be done on the secondary beaches before valid comparisons can be made to determine ratios for both beaches. The secondary beaches have to be sampled for at least one tide at the same time the major beach is being observed.

While one person is sampling major beaches, another can sample one beach per day of lesser used beaches. In subsequent tidal series, if there is enough confidence in the ratios, a count could be made at a given point in time to allow gross extrapolations over a much wider area.

An alternative to travelling to beaches by car or boat would be airplane overflights. These are used successfully in the Washington State intertidal fisheries monitoring program (Al Scholz, pers. comm.) and in the Georgia Strait Creel Survey (Shardlow 1983). In Washington State overflights are done in conjunction with beach sampling. An attempt is made to confine the overflight period to 75 min before and 60 min after low tide. This provides total beach activity for the survey area at various times. Conversion samples of this type are more accurate if taken during the period of maximum activity on the beach.

Flight characteristics vary with type of plane and activity to be monitored. The Georgia Strait Creel Survey uses overflights to monitor sport boat activity. They fly at 225 meters and about 130 knots using a Cessna 180 or a DeHavilland Beaver. The Washington State Department of Fisheries shellfish group overflights are used to monitor crab and clam harvesters on beaches. Using Cessna 185s they fly at 125-150 meters and about 100 knots. The Canadian Wildlife Service makes extensive use of flights for bird census. They fly at 150 m and at 100 knots or less, using Cessna 172-180s. Their survey methods change with species of bird and area surveyed (D. Smith, pers. comm.).

Observers must be able to distinguish the activity of a person on the beach when undertaking overflights of intertidal fisheries. A survey in

1979 by the Interagency Committee for Outdoor Recreation in Washington State noted that 63% of people on the beach were walking or beach combing and only 37% were actively fishing. Sport harvesters should be identifiable by equipment they have with them, fork, rake, crab loop, buckets etc.

Photographing the beach from an airplane is another method that can be used. Photos or slides can be enlarged and people's activity studied. This method is dependent on available light. The plane's speed may make it difficult to obtain sharp, well defined photos on dull days, or on bright days when the position of the sun relative to the plane is not suitable. Some experimentation with film type and speed, as well as lens type, and best flight pattern will be necessary. Photos can also be used as a check on observer counts, or as a backup on heavily used beaches.

The best pattern for overflights must be determined in each area to achieve maximum coverage in the least time. User patterns for weekday or weekend tides should also be assessed.

TRAP FISHERIES

There are trap fisheries for crabs, prawns, shrimp, and octopus along the entire coast. Trapping is the common method used to catch crab. While a large number of people set a trap on their way to fish salmon there are many who target on crabs, setting and pullling traps regularly throughout the year. The same behaviour may be true for fishing prawns. Octopus fishing is probably confined to certain docks or certain ethnic populations and is so small that it will not be considered.

Information needed for trap fisheries is:

- -Number of traps used (per person, or total)
- -How often are they fished
- -Catch information
- -Where fishing takes place
- -Type of trap used

This information, while straight forward, is difficult to collect.

There is no license requirement for invertebrate fishing in B.C., so there is no base population to survey. Several possible groups can be sampled to provide information, tidalwater license holders, boat owners, or a random selection of coastal B.C. residents.

The tidal water license holders represent some 300,000 people who fish finfish. While a large number of these people may put out traps for crabs and shrimp, the list would not include people who harvest only invertebrates.

Sampling the Department of Transport lists of registered vessels presents several problems. There is no separate category for pleasure vessels, so any list would include all vessels registered for customs ports in

the study area. Since registration is a one time event their lists also include many vessels that are inactive. Because registration is mandatory only for vessels over ten horsepower, skiffs, canoes and a large number of sailboats would be excluded.

The last choice is to use telephone books or voters lists and select a sample. In 1981 the Tidal Diary program did this, selecting 16,000 residential phone numbers. These were then used to identify households with one or more sport fishermen and a number of questionnaires were mailed out (Bijsterveld 1983). A similar approach was used in the resident boating survey (Harrison 1979). This type of survey would have the best base for making projections on trap fisheries. Results of such a questionnaire survey could be used to plan further sampling in areas of heavy fishing or to provide basic information for the management process.

A return post card or a return envelope system costs approximately two times the normal letter rate plus printing. A short questionnaire on a return post card was used by the tidal diary program in 1982. A suggested return post card questionnaire for trap fishing is given in Table 2.

Sampling trap fisheries on a continuing basis is also difficult. The Washington State Department of Fisheries uses a waterproof questionnaire package that is attached to trap bouys. This package contains an explanation of the survey and questionnaire, a voluntary catch diary, and two return envelopes (one for the questionnaire, one for the completed diary). Copies of the voluntary log and questionnaire are shown in Appendix 3. In Washington State, the fisheries regulations require a specific colour buoy for shrimp pots (yellow), and for crab pots (red and white). Commercial traps are also controlled. This allows samplers to be specific about the type of questionnaire attached to buoys. Response rate is quite high for these packets, 50-60% for shrimp and 45% for crab and the log follow up (Dick Bumgarner, pers. comm.). Without the luxury of coded buoys in British Columbia, questionnaires would have to be more general and one would expect less response because of packets placed on other types of buoys. The accuracy of this type of questionnaire can only be checked by doing local sampling.

A minor problem on the B.C. coast would be distributing questionnaires. It would require finding concentrations of buoys, and placing questionnaire packages on them. From non response to the first batch distributed, the non trap buoys, moorings and private navigation markers could be mapped and eliminated for future distribution. It would be best to concentrate this type of program in areas where other sources of information, general surveys, Fishery Officers, indicate heavy trap fishing, e.g. Sidney Spit, Ganges and Fulford Harbour, Nanaimo, Cates Park (North Vancouver), Roberts Bank (Terry Butler, pers. comm.), and Prince Rupert. Questionnaires could also be distributed to pleasure boats at popular moorages or anchorages. Another source for distribution of the packets would be trap lines hanging from docks. They also lend themselves to voluntary self creel census with a billboard explaining the program and questionnaires placed at the head of the dock (see intertidal fisheries for more detail). A sampler

monitoring dock activity throughout the day could sample the wharves. Miller and Gotshall (1965) employed this method in assessing California pier fishing. Anglers were interviewed and half hourly counts taken to determine fishing patterns. This is labour intensive if many docks are involved but yields accurate information. Once good monthly user curves were developed, a single person could drive and cover many piers in one day.

DIVE FISHERIES

All the popular recreational invertebrate groups except clams are harvested by divers. Abalone, Dungeness crab, and rock scallops are species most commonly taken by divers. Swimming scallops and prawns are also harvested but are only available to divers in certain locations. Preliminary estimates indicate abalone are taken at a rate of 1172 abalone/1000 sport dives, rock scallops 903/1000 sport dives, and Dungeness crab 508/1000 sport dives (McElderry and Richards 1984). There are two estimates of the annual number of dives in the Strait of Georgia. McElderry and Richards (1984) using the October-November period as a base give a range of 76-172 thousand dives/year, Berry estimates 300,000 dives per year on the coast. Most are in the Strait of Georgia (Ernst et al. 1980). The large diving population, and diversity of collection attitudes and patterns make it difficult to sample diving. Another factor that makes sampling difficult is the number of dive sites. Most sites in the Strait of Georgia and Gulf Islands have road access or need only a small boat from the nearest ramp to reach the site. In situ sampling is impossible and divers rarely are concentrated in one place, making access point sampling unproductive.

California Method for Assessment of Dive Fisheries

The California Department of Fish and Game assesses two separate dive fisheries for species similar to those taken in B.C. These are "skin" or free divers and SCUBA divers. Both groups are capable harvesters, and are more harvest oriented than B.C. divers. Miller and Gotshall (1965) reported SCUBA divers spent 62% of diving time fishing, and free divers spent 48% of their time harvesting finfish and 38% picking abalone. California Fish and Game sampled this fishery in three ways (Miller and Gotshall 1965, Miller et al. 1974): Voluntary log books for clubs, access point sampling, and monitoring charter boats. Voluntary log books distributed to members of "skin" and SCUBA diving clubs requested information on time spent harvesting, and catch by species on a single dive basis. Data were compiled by area since changes in target species may reflect species composition from area to area. Access point sampling was done to provide a check on log book information in various areas. This was possible because most of the areas had a limited number of access points along a rocky coast.

The third method used in California was a log system for 'party' or charter boats. Skippers kept a log of diver hours and catch on a daily trip basis. If carefully administered, this is an inexpensive source of catch and effort data. An occasional trip by a sampler on these boats provides a check on log reliablity.

Application of California Method to British Columbia

These sampling methods are difficult to apply to B.C., particularly in the Strait of Georgia and Gulf Islands, since an access point survey would require a large number of samplers, all with good local knowledge of diving and local road access. Voluntary logs for club members would probably work well in the North Coast District where the club is often the focus for diving in remote places. In the South Coast District club members are a small part of the total diving population. Club membership might also represent an interest in one particular diving activity such as photography or archaeology thus giving a biased sample. Dive shops or dive magazines might be a better source for distribution of voluntary logs or questionnaires as was found in the McElderry and Richards (1984) study.

In southern B.C. charter boats generally do not allow harvesting on dives. It takes time to find good dive locations and these operators consider it in their interest to preserve the areas. In northern areas with fewer operators, fewer trips, and more diving opportunities, harvesting is more common on charters but is still limited.

There are five major questions to be answered for dive fisheries. What is the diving population? How often do they dive? How much harvesting is done? What species are harvested? Where is diving effort concentrated? Initial answers to these questions at least for the Strait of Georgia are provided in the 1984 Survey (McElderry and Richards 1984). Further studies may be undertaken to obtain information on the seasonal nature of the fishery, to assess other areas, to improve estimates of dive time spent harvesting or to obtain additional information for management purposes.

In B.C. there may be significant pressure on certain species in specific areas, but it is unlikely that sport diving generally is having a profound effect on invertebrate populations. The effect on popular species in specific areas can be studied using modifications of the California sampling method, or through other questionnaire studies. These studies should be done in summer months the season of most active diving. Areas for futher study would need to be identified either by consulting Fishery Officers, or identifying areas of conflict.

OTHER CONSIDERATIONS

Investigation of the impact of recreational fisheries on invertebrate stocks in British Columbia will be a complex problem and will require careful and detailed planning. The basic problem is to obtain baseline estimates of the number of people harvesting shellfish recreationally along with information on areas of harvesting and species taken. An easy and effective method to do this might be to institute a licensing system for recreational shellfish harvesters; this could be an adjunct to the tidal finfish license or preferably a separate license. There may be serious ojections to such a license but the feasibility of instituting it should be investigated. Licensing would be handled by the licensing section of Fisheries and Oceans and could pay for itself through a nominal license fee.

Although existing programs to monitor the sport finfish fishery are not suitable in their present form to assess the recreational shellfish fishery, it may be possible to modify them to enable collection of data that is pertinent to the recreational invertebrate harvest. For detailed information it will be necessary to insititute specific programs to investigate recreational invertebrate harvest and these have been outlined in previous sections. Initially, sampling should be confined to one area and to one group of shellfish; e.g. intertidal clams in the Strait of Georgia. Extensive recreational fisheries exist for intertidal clams in the Strait and areas of heavy harvest are known. The survey could then be extended to other groups or species.

An assessment of recreational dive fisheries has been made but should probably be extended to fill in gaps in the information and to determine the seasonal nature of the fishery. This might be done by distributing a questionnarie or intensive sampling in a specific area. The questionnaire should be carefully prepared to ensure all the required information is collected.

The program will involve considerable contact with the public and every effort must be made to maintain the goodwill of the public to insure the success of the program. An extensive publicity program should be mounted prior to any sampling to explain the program, sampling methods, aim of the program and potential benefits for recreational harvesters. Samplers would have to be carefully chosen and trained in both sampling techniques and in dealing with the public. The Georgia Strait Creel Survey personnel could provide information in this area; their screening and training programs could be reviewed and adapted for this program. The program will also require a well defined system to direct enquiries samplers will receive on sport fishing related quesitons to proper sources for answers.

In the initial stage the program should be regarded as experimental and results should be carefully evaluated regularly to assess quality and quantity of data collected so that adjustments can be made to fill any gaps

that may occur. Eventually a program will evolve that will enable adequate sampling of the fishery to provide an assessment of the impact of the recreational fishery on invertebrate stocks in British Columbia.

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We are also indebted to personnel of the Washington State Department of Fisheries Shellfish Laboratory at Point Whitney, particularly A. Scholtz and D. Bumgarner, who were most helpful in explaining their programs to assess recreational fisheries in that State.

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Table 1. Species harvested in the British Columbia recreational invertebrate fishery.

	Intertidal Fisheries	
Butter clam	*Saxidomus giganteus*	Along entire coast
Littleneck clam	*Protothaca staminea*	Along entire coast
Manila clams	*Tapes philippinarum*	Strait of Georgia and inlets of west coast of Vancouver Island
Razor clam	*Siliqua patula*	Ocean swept sand beaches at Long Beach on west coast of Vancouver Island and east of Masset in Queen Charlotte Islands
Pacific oyster	*Crassostrea gigas*	Strait of Georgia, Barkley and Clayoquot Sounds
Blue mussel	*Mytilus edulis*	Along entire coast
Rock scallop	*Chlamys gigantea*	Along entire coast
Northern abalone	*Haliotis kamtschatkana*	Alone entire coast
Dungeness crab	*Cancer magister*	Along entire coast
Red rock crab	*Cancer productus*	Along entire coast
	Trap Fisheries	
Dungeness crab	*Cancer magister*	Along entire coast
Red rock crab	*Cancer productus*	Along entire coast
Prawn, spot shrimp	*Pandalus platyceros*	Along entire coast
Pink shrimp	*Pandalus borealis*	Along entire coast
Smooth pink shrimp	*Pandalus jordani*	Along entire coast
Coonstripe shrimp	*Pandalus danae*	Along entire coast
Humpback shrimp	*Pandalus hypsinotus*	Along entire coast
	Dive Fisheries	
Rock scallop	*Chlamys gigantea*	Along entire coast
Pink scallop	*Chlamys rubida*	Along entire coast
Spiny scallop	*Chlamys hastata*	Along entire coast
Norther abalone	*Haliotis kamtschatkana*	Along entire coast
Octopus	*Octopus dofleine*	Along entire coast
Sea cucumber	*Parastichopus californicus*	Along entire coast
Sea urchins	*Strongylocentrotus franciscanus purpuratus*	Along outer coast

Table 2. Questionnaire that could be used to assess the recreational trap fishery in British Columbia.

1. Do you trap or ring fish for crabs _____ Prawns _____.

2. How many traps do you use. Crabs _____ Prawns _____.

3. How often do you fish for crabs or prawns in days per month.

	Crab	Prawn		Crab	Prawn		Crab	Prawn		Crab	Prawn
Jan	___,	___	Apr	___,	___	July	___,	___	Oct	___,	___.
Feb	___,	___	May	___,	___	Aug	___,	___	Nov	___,	___.
Mar	___,	___	Jun	___,	___	Sep	___,	___	Dec	___,	___.

4. How many crabs did you catch and keep in 1985 ____.

5. How many Kgs of prawns (Shrimp) did you catch in 1985 ___Kg.

6. What three statistical areas did you fish most in 1985 ___, ___, ___.

7. Do you have a tidal water license, yes ___, no___.

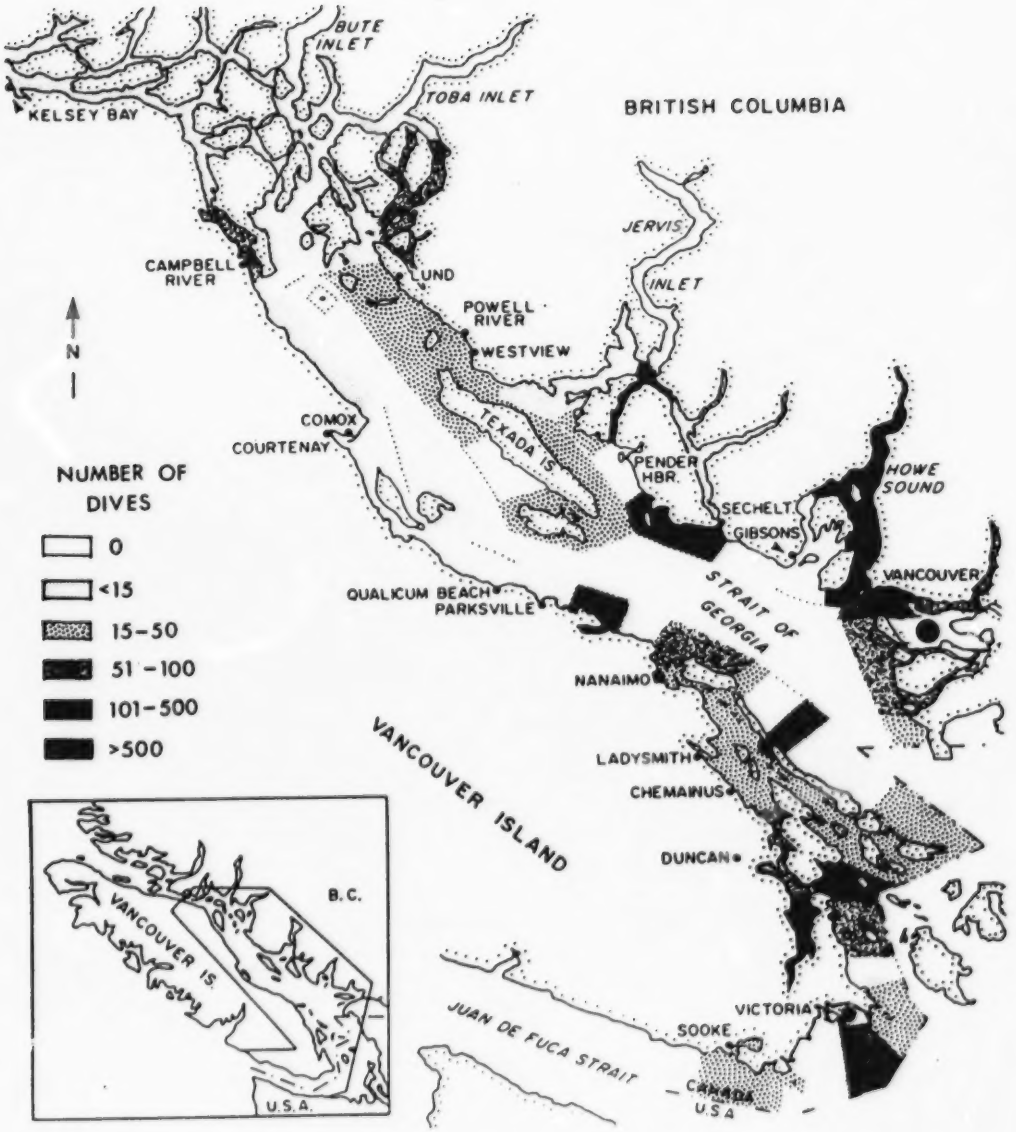

Fig. 1. Distribution of diving effort in the Strait of Georgia when all sample locations were combined. N = 488 (After McElderry and Richards 1984).

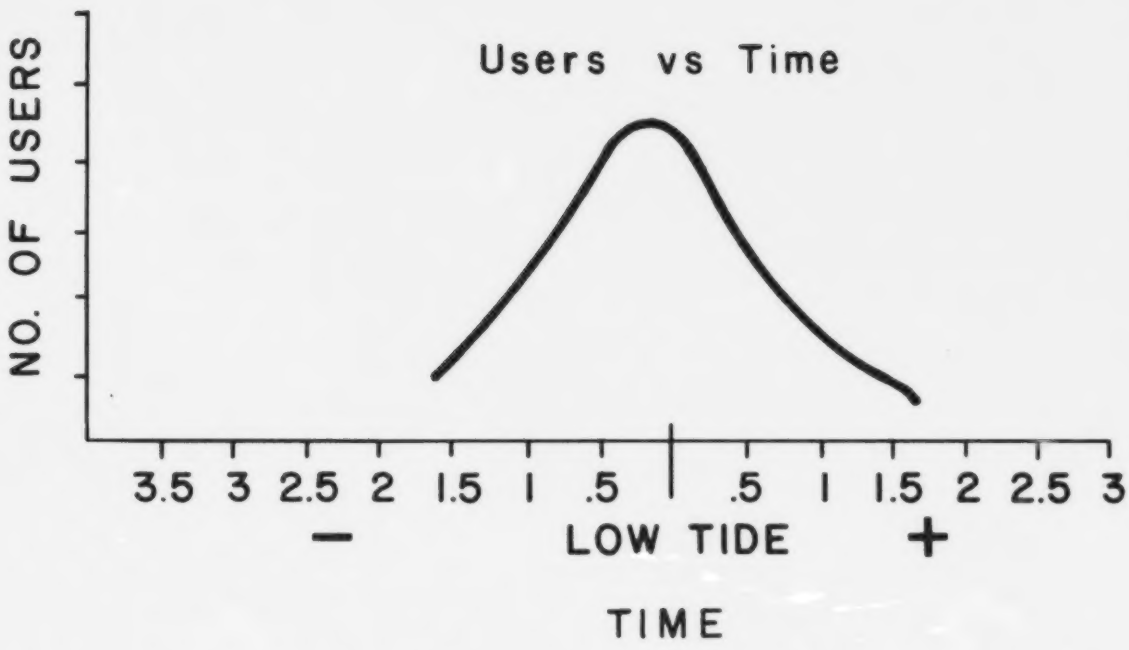

Fig. 2. An example of the general relationship between number of recreational harvesters on an intertidal beach and the state of the tide.

Appendix 1. Questionnaire distributed to Fishery Officers and Supervisors concerning recreational harvesting of invertebrates in their area.

Which of the following species are taken in recreational fisheries in your area? Please check by species or group.

Rank:

- Alabone
- Clams: littleneck, manila, butter, cockle, razor
- Crabs: rock, Dungeness, king
- Goose Neck Barnacles
- Mussels: blue, California
- Oysters
- Octopus
- Prawns and Shrimp: all species
- Scallops: rock, swimming
- Squid
- Sea Cucumbers
- Snails
- Urchins

Please rank the 5 largest recreational shellfish fisheries for your area on the left of the above list.

Please list (or show on a chart) the major areas where the 5 major fisheries take place and whether access is by boat or car (walking). Use any extra pages required.

How are crabs caught in your area? Please indicate by percentage:

- Trap
- Ring
- Low tiding
- Diving

Are any of the major recreational shellfish fisheries done in conjunction with other recreational fishing? An example would be a salmon fisherman, who throws out a crab trap on the way to the salmon fishing.

Are the participants in the 5 major fisheries local or transient?

Species	% local	% transient

How many charter boats (diving, fishing, sight seeing) operate in your area?

Appendix 1 (cont'd)

How many fishing lodges or fish camps (fixed or floating) operate in your area?

Would these vessels or lodges be harvesting recreational shellfish? What species.

Are there any conflicts between sport and commercial shellfish fishermen in your area? Describe.

Does your office have any formal survey data on recreational shellfish harvesting? Describe.

Appendix 2. Suggested questions for developing a user profile curve for clam beaches.

CLAM QUESTIONS

Where?	Do you always dig on this beach? Where else do you dig?
When?	What seasons do you dig? Any good tide day or night?
How often?	How many times a year do you dig? Each day in good tide series? How long are you on the beach at one time?
What species?	Which species do you target? How many species do you recognize? Do your methods change with species?
Final use?	What is the final use, eaten fresh, canned, or chowder?
Amount?	How many clams do you take in a year season?
Regulations?	Are you familiar with the regulations?
No. of diggers?	How many people are in the party? How many are actually digging?

Measuring of catch by the bucket and board method. % mm groups by species.

Separate questionnaire for razor clams.

Interviews on beach or at good point where people are comming off beach.

Appendix 3. Questionnaires and log books used by the Washington State Department of Fisheries to monitor recreational trap fisheries for crabs and shrimp.

STATE OF WASHINGTON
John Spellman
Governor

DEPARTMENT OF FISHERIES
600 Point Whitney Road, Brinnon, Washington 98320
206 796-4601, 206 754-1998
SCAN 245-1998

Serial Number_____

Dear Fisherman:

We attached this packet to your buoy so that the Department of Fisheries can learn more about the personal-use pot fisheries for crabs and shrimp. Our goal is to improve these fisheries, but without your help we cannot succeed. An addressed, stamped envelope is enclosed for your convenience in returning the completed questionnaire.

PLEASE COMPLETE AND RETURN THIS QUESTIONNAIRE AS SOON AS POSSIBLE WHETHER OR NOT ANY CRABS OR SHRIMP ARE CAUGHT.

If you received additional questionnaire(s), please complete only one, and record the serial number(s)_____, of other(s) received.

Some questions will require an estimate. Your best guess will be sufficient unless you feel that your answer would be very inaccurate. If this is the case, then please leave that question unanswered.

1. This questionnaire was attached to:
   a) crab pot marker buoy_____.
   b) shrimp pot marker buoy_____.

The next two questions refer to all pots fished by you whether or not questionnaires were attached to the buoys.

2. If crab fishing:
   a) How many pot(s) do you attach to each marker buoy line_____?
   b) How many crab pot(s) did you just check_____?
   c) How many hours were the pot(s) in the water since last checked_____?
   d) How many legal sized male Dungeness crabs were caught in the pot(s) since last checked_____, and how many were kept_____?
   e) How many Rock crabs were caught in the pot(s) since last checked _____, and how many were kept_____?

3. If shrimp fishing:
   a) How many pot(s) do you attach to each marker buoy line_____?
   b) How many shrimp pots did you just check_____?
   c) How many hours were the pot(s) in the water since last checked_____?
   d) How many pounds_____ or numbers_____ of shrimp were caught in the pot(s) since last checked?

4. Are you currently keeping a log of your pot fishing for us? Yes_____ No_____
   If yes, please disregard question #5.

5. If you are not currently keeping a log for us, would you be willing to do so using the enclosed log?
   Yes_____(Please print your name and address below) No_____

Name_____

Address_____

City and State_____

Zip_____

Sincerely,

Bill Wilkerson

William R. Wilkerson
Director

STATE OF WASHINGTON
John Spellman
Governor

DEPARTMENT OF FISHERIES
600 Port Whitney Road, Brinnon, Washington 98320
206/796-4601, 206-754-1498
SCAN 235-1498

Serial Number:_____

Dear Fisherman:

We attached this packet to your buoy so that the Department of Fisheries can determine the magnitude of recreational shrimp fishing effort and catch in Hood Canal waters. This important information is critically needed so that we may continue to make improvements in management of this resource. However, without your help we cannot succeed.

PLEASE COMPLETE AND RETURN THIS QUESTIONNAIRE AS SOON AS POSSIBLE WHETHER OR NOT ANY SHRIMP ARE CAUGHT.

If you received additional questionnaire(s) please complete only one, and record the serial number(s)_____, of other(s) received.

Some questions will require an estimate. Your best guess will be sufficient unless you feel that your answer would be very inaccurate. If this is the case, then please leave the question unanswered.

1. This questionnaire was attached to:

   a) Shrimp pot marker buoy_____.
   b) Other buoy (please specify)_____.

2. The next four questions refer to all pots pulled by you today, whether or not the questionnaires were attached to the buoys.

   a) How many pot(s) do you attach to each marker buoy line?_____.
   b) How many shrimp pot(s) did you just check?_____.
   c) How many hours were the pot(s) in the water since last checked?____.
   d) How many pounds_____ or numbers_____ of shrimp were caught in the pot(s) since last checked?

We have included a pot fishing log so that we can obtain catch information through the entire season. The data you provide will remain confidential and will be used to help determine the total number of shrimp caught for personal use in your area. Please complete this log after each day's fishing and return it by July 10, 1984.

Thank you for your help and participation in this program.

Good Fishing!

Sincerely,

Bill Wilkerson

William R. Wilkerson
Director

Serial No. _____

PERSONAL-USE SHELLFISH
POT FISHING LOG

YEAR _____

NAME_____

ADDRESS_____

CITY_____ STATE_____ ZIP_____

Please return this log by_____

Wash. Dept. of Fisheries
Pt. Whitney Shellfish Lab
600 Pt. Whitney Road
Brinnon, WA 98320

Area Fished: (Nearest Landmark and Bay)	Number of Pots Fished For:		Date Pots Checked	Soak Time*	Shrimp Caught		Number of Male Dungeness Crabs					Comments
							6 to 6¼"		6¼ & Larger		Under 6"	
	Shrimp	Crab			Pounds	OR Number	Caught	Kept	Caught	Kept	Returned	

*SOAK TIME means the number of days (to the nearest half-day) since you last checked or set the pot(s).

Serial No._____

PERSONAL-USE SHRIMP
POT FISHING LOG

YEAR_____

NAME:_____

ADDRESS:_____

CITY:_____STATE_____ZIP_____

Please return this log by:_____

Wash. Dept. of Fisheries
Pt. Whitney Shellfish Lab.
1000 Pt. Whitney Road
Brinnon, WA 98320

Specific area fished (use prominent land mark)	Todays date		Number of pots just checked	Time checked	No. of hours since pots were last checked	Shrimp caught and/or		Apprx. depth fished	Comments
	Month	Day				Number	Pounds		